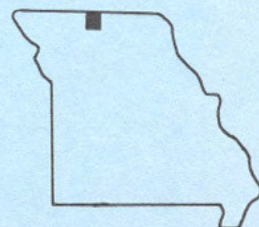


WATER POSSIBILITIES FROM THE  
GLACIAL DRIFT OF  
MERCER COUNTY

BY

J. R. McMILLEN

W. B. RUSSELL



Water Resources Report 2

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OF MERCER COUNTY

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1956

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MISSOURI GEOLOGICAL SURVEY AND WATER RESOURCES Rolla, Mo.

William C. Hayes, State Geologist and Director



## WATER POSSIBILITIES FROM THE GLACIAL DRIFT OF MERCER COUNTY

A special study of groundwater by the Missouri Geological Survey and Water Resources was made possible at the 1955 session of the Missouri Legislature. With the approval of the Governor, money was appropriated from the Missouri Post War Surplus Reserve Fund.

Since nearly two-thirds of the counties located north of the Missouri River are deficient in water supplies, much of the effort of this special study is being directed toward the problems of this area.

It is hoped that a program of test drilling will locate new reserves of groundwater. Potential areas are being tested so that additional supplies will be available for irrigation, municipal, industrial and domestic needs.

The most favorable areas are in the channels and valleys of pre-glacial and inter-glacial streams where the sand and gravel beds of glacial drift are thick. As these buried valleys do not conform to present day drainage patterns, a systematic program of test drilling is the best means of locating the channels and mapping their extent. Similar glacial deposits have proved to be excellent sources of groundwater throughout other sections of the midwest.

### QUALITY OF WATER FROM ROCK WELLS

In many areas of Mercer County, the glacial drift is either thin or lacking in sand and gravel beds of sufficient thickness to carry appreciable amounts of water. (Plate 1 shows the most favorable areas for the development of wells in glacial drift). Since much of the county is unfavorable for the development of glacial drift wells, it is worthwhile to examine the possibilities of obtaining water from the bedrock beneath the glacial deposits.

The water from these consolidated rock formations which underlie Mercer County is highly mineralized. In general the mineral content of the water increases with depth in rock wells. Several shallow wells have been drilled through the glacial drift into consolidated sandstones and small

production (1 to 10 gallons per minute) developed. The water encountered has proved satisfactory for domestic use as the mineral content has not been prohibitive.

At the present time there is no assurance that all wells drilled into the consolidated rock formations in Mercer County will yield sufficient water or satisfactory water. Only limited data are available, but as more such wells are drilled it may be possible to outline definite potential areas where shallow rock wells may be obtained.

The following analyses give data concerning the quality and quantity of water from consolidated rock wells:

CONSTITUENTS	IN PARTS PER MILLION		
	I	II	III
Turbidity	15	40	30
Odor	None	None	None
Color	-----	-----	-----
pH	7.9	7.3	7.45
Alkalinity (CaCO <sub>3</sub> )	1080.5	284.0	219.0
Phenolphthalein	62.0	0.0	0.0
Methyl Orange	1018.5	284.0	219.0
Carbonate (CO <sub>3</sub> )	37.2	0.0	0.0
Bicarbonate (HCO <sub>3</sub> )	1242.6	346.5	245.2
Silica (SiO <sub>2</sub> )	6.5	10.7	9.3
Oxides (Al <sub>2</sub> O <sub>3</sub> , Fe <sub>2</sub> O <sub>3</sub> , TiO <sub>2</sub> , etc.)	2.5	1.0	2.3
Calcium (Ca)	41.1	193.0	162.0
Magnesium (Mg)	29.2	76.8	77.5
Sodium (Na) and Potassium (K) as Na	744.4	335.2	531.9
Total Manganese (Mn)	0.00	0.00	0.00
Iron (Fe)	2.74	3.92	2.34
Dissolved Iron	0.005	0.47	0.36
Precipitated Iron	2.73	3.45	1.98
Sulfate (SO <sub>4</sub> )	313.2	1139.9	1407.4
Chloride (Cl)	277.5	10.5	11.5
Nitrate (NO <sub>3</sub> )	0.0	0.0	0.6
Fluoride (F)	1.6	0.5	0.7
Total Suspended Matter	11.	14.	0.
Total Dissolved Solids	2011.	2032.	2339.
Total Hardness	222.8	798.1	723.6
Carbonate Hardness	1080.5	284.0	219.0
Non-Carbonate Hardness	0.	514.1	504.6
Per Cent of Alkalies	87.91	47.75	61.53

(I) Owner: Mercer Public Schools, Mercer, Missouri. SW1/4NW1/4 sec. 20, T. 66N., R. 23W., total depth 450 feet into rocks of the Pennsylvanian System. Well cased to bottom with casing slotted at 240'-250' in zone of Pennsylvanian sandstones. Static water level 93 feet. Yield 4.8 gallons per minute. Temperature 58° F. Sample collected January 5, 1956. Analyst: M. E. Phillips.

(II) Owner: Russell Goodin, SE1/4SE1/4SW1/4 sec. 3, T. 65 N., R. 23 W., total depth 142 feet into sandstones of the Pennsylvanian System. Well cased to bottom with casing slotted in lower 10 feet. Static water level 47 feet. Yield 10 to 12 gallons per minute with complete drawdown to bottom. Sample collected February 13, 1956. Analyst: M. E. Phillips.

(III) Owner: Gerald Gentry, NW1/4SW1/4NW1/4 sec. 17, T. 64 N., R. 24 W., total depth 154 feet into rocks of Pennsylvanian System. Water developed from sandstone at 140' level. Casing extends to total depth of well with lower 20 feet slotted to allow water to enter. Static water level 70 feet. Yield 2 gallons per minute. Temperature 52° F. Sample collected March 7, 1956. Analyst: M. E. Phillips.

#### QUALITY OF WATER FROM STREAMS

The streams of Mercer County are for the most part intermittent in their flow. As a result they are not suitable for irrigation even though the quality of the water is satisfactory. Following is an analysis of water taken from Weldon River at Mill Grove:

CONSTITUENTS	IN PARTS PER MILLION
	(A)
Turbidity	100
Odor	None
pH	7.85
Alkalinity (CaCO <sub>3</sub> )	195.5
Phenolphthalein	0.0
Methyl Orange	195.5
Carbonate (CO <sub>3</sub> )	0.0
Bicarbonate (HCO <sub>3</sub> )	239.0
Silica (SiO <sub>2</sub> )	5.0
Oxides (Al <sub>2</sub> O <sub>3</sub> , Fe <sub>2</sub> O <sub>3</sub> , TiO <sub>2</sub> , etc.)	0.8
Calcium (Ca)	64.1
Magnesium (Mg)	13.2
Sodium (Na) and Potassium (K) as Na	15.7
Total Manganese (Mn)	0.00
Iron (Fe)	1.52
Dissolved Iron	0.08
Precipitated Iron	1.44
Sulfate (SO <sub>4</sub> )	40.0
Chloride (Cl)	4.3
Nitrate (NO <sub>3</sub> )	0.1

CONSTITUENTS	IN PARTS PER MILLION
	(A)
Fluoride (F)	0.6
Total Suspended Matter	30.
Total Dissolved Solids	279.
Total Hardness	214.3
Carbonate Hardness	195.5
Non-Carbonate Hardness	18.8
Per Cent of Alkalies	14.0

(A) Weldon River at Mill Grove, sec. 28, T. 64 N., R. 24W., samples October 26, 1955. Temperature of water 56° F. Temperature of air 72° F.  
Analyst: M. E. Phillips

#### QUALITY OF WATER FROM GLACIAL DRIFT

In general the water from the glacial drift in Mercer County is high in total iron, total dissolved solids and sulfates. The iron content in the water may cause some staining of the plumbing fixtures and clothes which are laundered. Relatively inexpensive water treatment for the iron will make the water usable. Preferably, the total dissolved solids should not exceed 500 parts per million but as high as 3000 parts per million may be tolerated if the odor and taste are not objectionable. However, for most thpes of irrigation the total dissolved solids should not exceed 2000 parts per million. If the sulfate content exceeds 500 parts per million the water may have a laxative effect upon individuals until they become adjusted to drinking it.

The water from the drift is superior to the water from consolidated rock wells in nearly every respect. One exception may be the relatively high iron content in the water samples from "sheet-water" (i.e. wells that are developed in the reworked glacial sands and gravels of present day valleys).

Following are analyses from three wells developed in glacial drift and one from reworked glacial sands (City of Princeton):

CONSTITUENTS	IN PARTS PER MILLION			
	I	II	III	IV
Turbidity	--	25	--	80.0
Odor	None	None	None	--
Color	--	--	--	--
pH	7.7	7.45	7.45	6.4

CONSTITUENTS	IN PARTS PER MILLION			
	I	II	III	IV
Alkalinity (CaCO <sub>3</sub> )	233.5	417.5	744.0	203.0
Phenolphthalein	0.0	0.0	0.0	0
Methyl Orange	233.5	417.5	744.0	--
Carbonate (CO <sub>3</sub> )	0.0	0.0	0.0	0.0
Bicarbonate (HCO <sub>3</sub> )	284.9	509.4	907.7	247.4
Silica (SiO <sub>2</sub> )	11.0	16.6	16.5	12.0
Oxides (Al <sub>2</sub> O <sub>3</sub> , Fe <sub>2</sub> O <sub>3</sub> , TiO <sub>2</sub> , etc.)	1.0	2.3	4.0	---
Calcium (Ca)	68.1	235.8	107.2	78.6
Magnesium (Mg)	21.4	76.8	32.5	15.5
Sodium (Na) and Potassium (K) as Na	70.8	164.1	138.1	17.3
Total Manganese (Mn)	0.0	0.00	--	--
Iron (Fe)	0.35	2.63	--	12.0
Dissolved Iron	0.32	0.05	0.82	--
Precipitated Iron	0.03	2.58	--	--
Sulfate (SO <sub>4</sub> )	144.7	726.8	14.2	81.3
Chloride (Cl)	17.3	17.0	2.5	16.2
Nitrate (NO <sub>3</sub> )	0.0	7.9	0.1	--
Fluoride (F)	0.4	0.4	--	--
Total Suspended Matter	--	101.	--	--
Total Dissolved Solids	474.	1518.	432.	392.0
Total Hardness	258.2	905.0	401.5	260.0
Carbonate Hardness	233.5	417.5	744.0	203.0
Non-Carbonate Hardness	24.7	487.5	.0	57.0
Per Cent of Alkalies	37.37	28.29	42.09	12.64

(I) Missouri Geological Survey, Test Hole #118. SE1/4NE1/4 sec. 6, T. 66 N. R. 25 W., total depth 220 feet. Collected February 7, 1956. Analyst: M. E. Phillips.

(II) Owner: Wilburn Widner, SE1/4SE1/4 sec. 33, T. 67 N., R. 22 W., total depth 165 feet. Temperature 48° F. Collected January 5, 1956. Analyst: M. E. Phillips.

(III) Missouri Geological Survey, Test Hole #84. SE1/4SE1/4 SW1/4 sec. 31, T. 66 N., R. 25 W., Total depth 290 feet. Collected December 22, 1955. Analyst: M. E. Phillips.

(IV) Owner: City of Princeton, SE 1/4 sec. 28, T. 65N., R. 24 W., composite water sample from wells nos. 1, 2, 3 and 4 developed in fluvial sands and gravels, approximately 40 feet deep. Analyzed by State Division of Health, September 12, 1955.

#### QUANTITY OF WATER FROM GLACIAL DRIFT

In this report water wells will be classed as domestic wells or irrigation wells. Those developed for household or general farm use are domestic wells. Irrigation wells are those of sufficient capacity to be used for industries, cities or farm irrigation.

Domestic Wells - Yields required for domestic wells may vary from 1 to 25 gallons per minute. In some parts of Mercer County (areas not in the deep pre-glacial valleys or channels) the glacial drift cover is relatively thin or entirely lacking. In those areas where there is little glacial drift the possibilities of developing domestic wells are limited. Plate No. 1 shows the most favorable areas. It is impossible to estimate accurately the average well depths because of the variations in bedrock elevations as well as the differences in surface elevations from one location to another. Plate No. 3 is a contour map showing the elevation above sea level of the bedrock. To obtain an estimate of the glacial drift thickness for a specific location, subtract the elevation of the bedrock at that point from the ground level elevation. Plate No. 3 also shows the location of each test hole with the thickness of the glacial drift and elevation above sea level of the bedrock at that point.

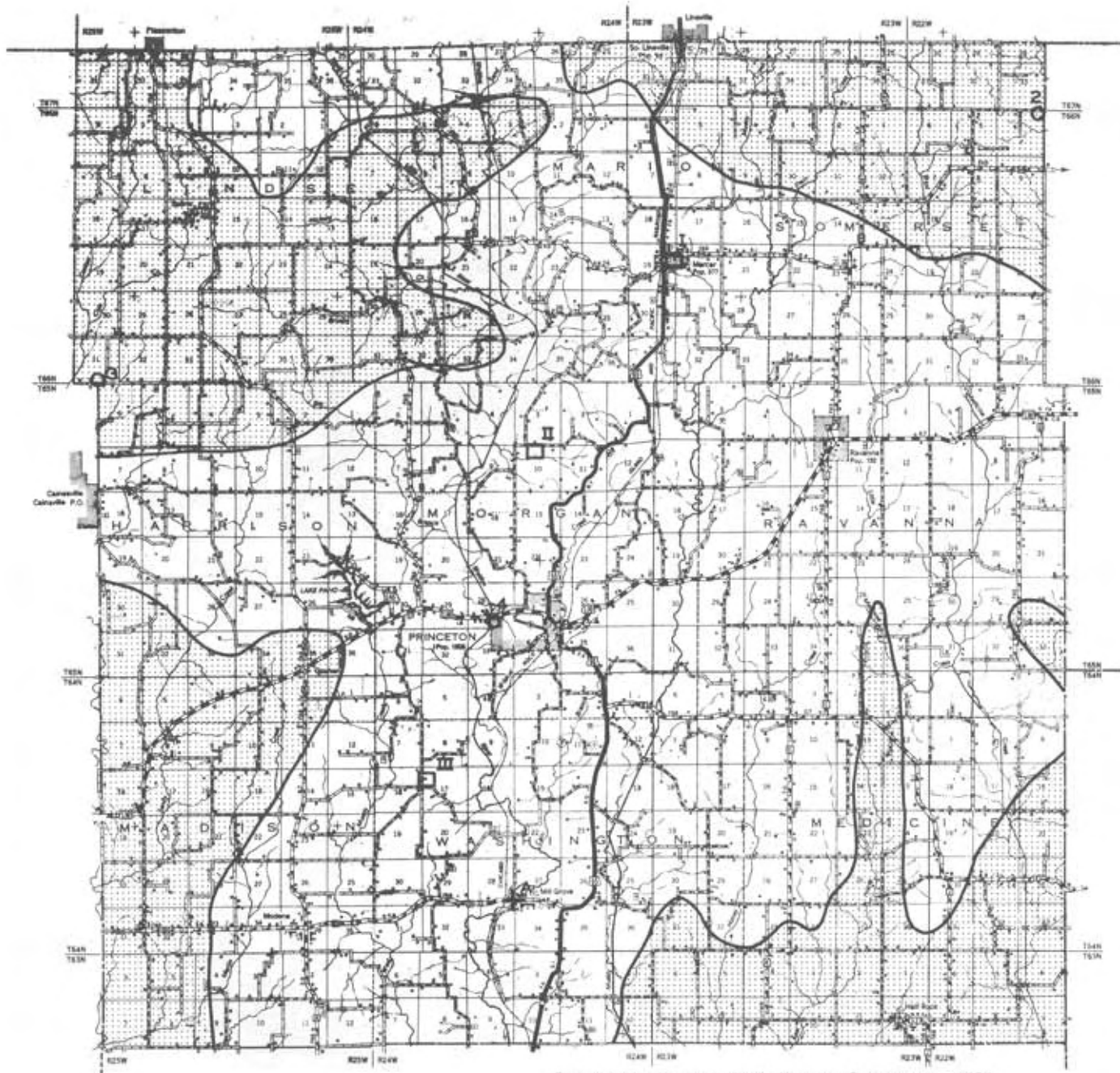
Irrigation Wells - Shown on Plate No. 2 are the areas most favorable for the development of irrigation wells. Unfortunately, Mercer County is in an area where drift-filled channels are found only in the extreme southeastern, extreme southwestern and northwestern parts. In these indicated channel regions the total thickness of sand and gravel zones averages from 100 feet to 200 feet. With proper development it is anticipated that yields of 200 to 1000 gallons per minute may be achieved in irrigation wells. The success of such wells will depend upon a number of factors:

- (1) Permeability of these sand and gravel horizons
- (2) Re-charge rate of those water-bearing zones
- (3) Ability of the well driller to develop the full capacity of the aquifer (this includes not only the proper techniques of drilling the well but also the proper choice of development by gravel pack, proper well screen, etc.)
- (4) Continued successful production is contingent upon the quality of screen and materials used in the well development because it will probably be necessary to acidize and treat the well screen and water-bearing formations for incrustations at a later date.

The sieve analyses on Plate No. 4 are presented to illustrate their use in the development of wells in sands and gravels.





In the analyses, the cumulative per cent (by weight) retained in each test sieve is plotted as a point on the graph against the sieve openings in





Base by the Missouri State Highway Department, 1950

# LEGEND

-  Area most favorable
-  Location of wells in drift from which water was analyzed.
-  Stream water sample analyzed.
-  Water sample analyzed from a "rock" well.

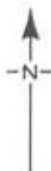


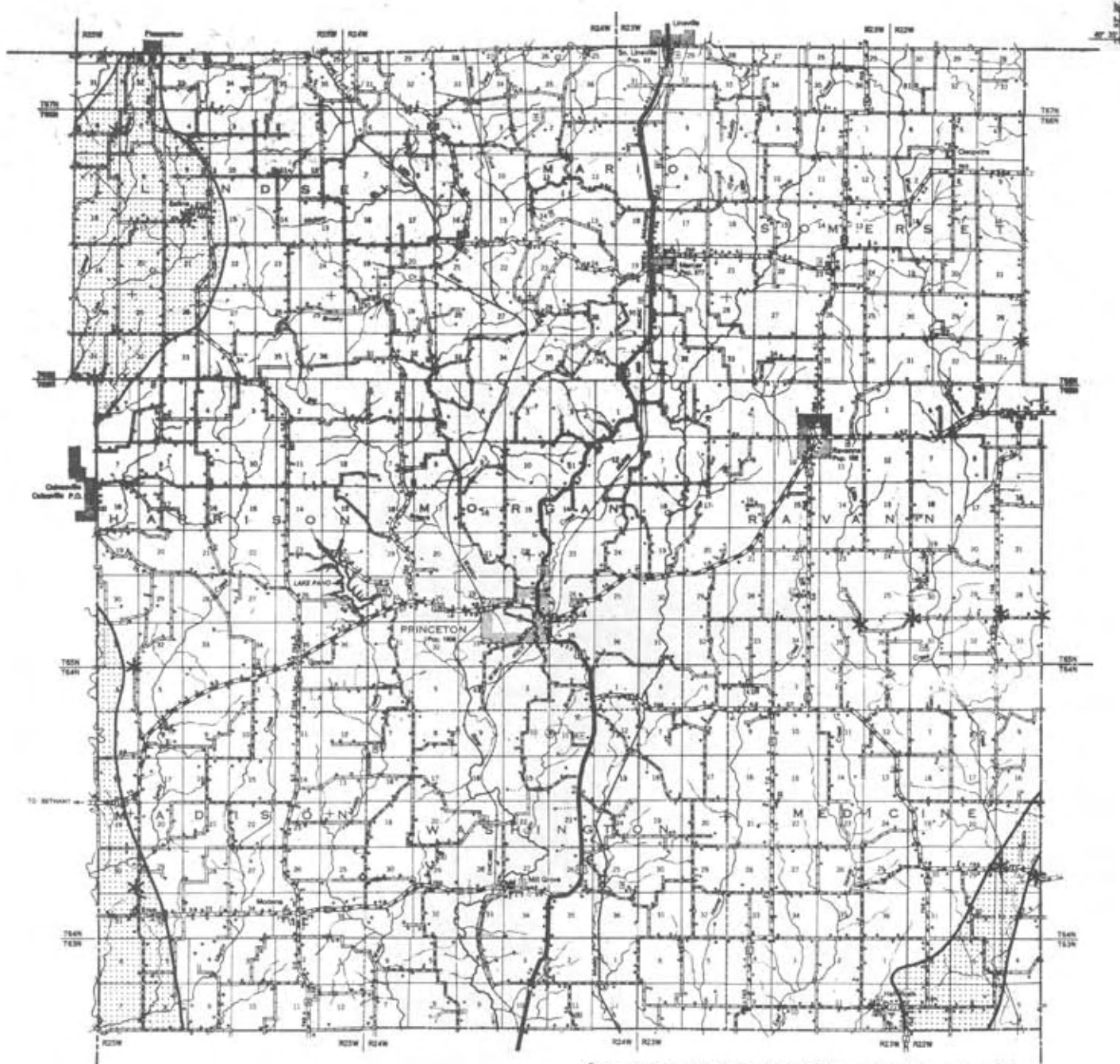
PLATE I

## MAP OF MERCER COUNTY SHOWING AREAS MOST FAVORABLE FOR THE DEVELOPMENT OF WELLS IN GLACIAL DRIFT

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AND  
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1956

MISSOURI GEOLOGICAL SURVEY  
AND WATER RESOURCES  
ROLLA, MISSOURI

THOMAS R. BEVERIDGE  
STATE GEOLOGIST



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# LEGEND



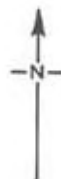
Drift filled valley.



Test wells that flowed.



Sand analysis from this well shown on plate four.



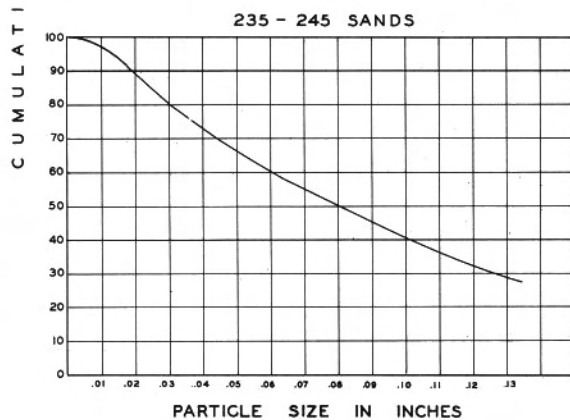
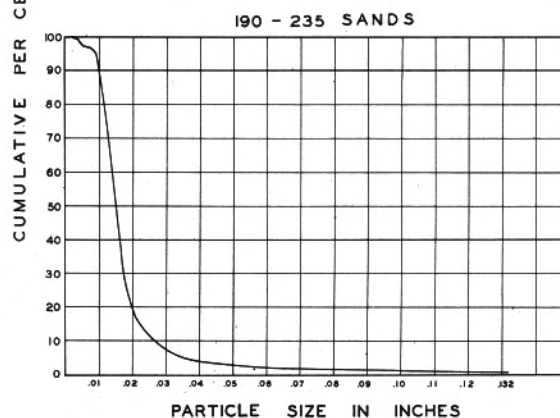
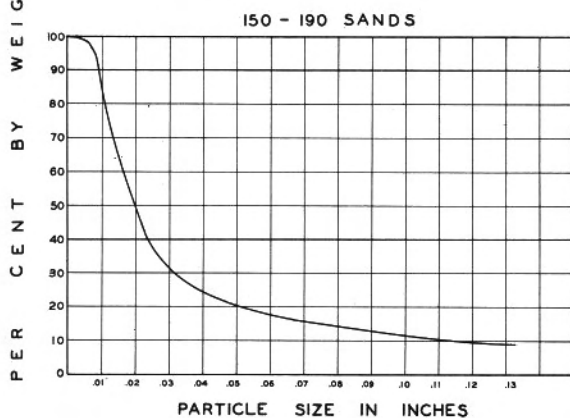
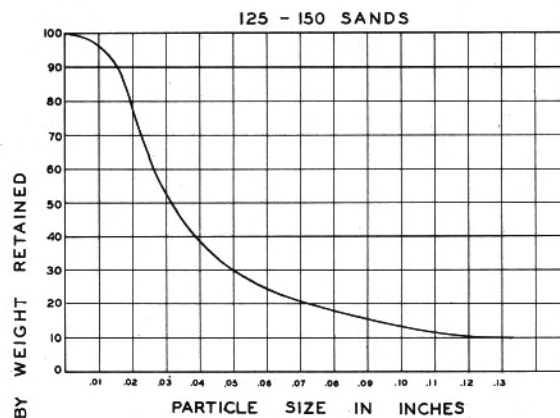
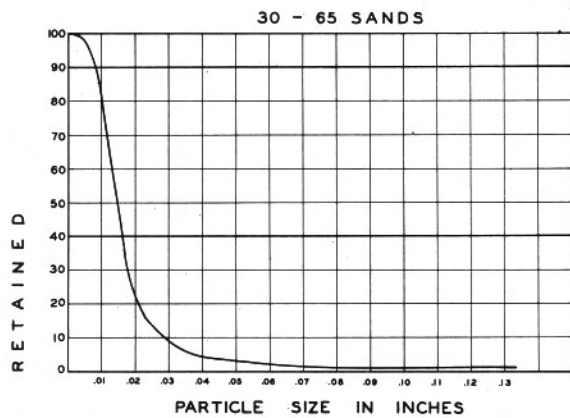
## MAP OF MERCER COUNTY SHOWING DRIFT FILLED VALLEY IN WHICH IRRIGATION WELLS POSSIBLY CAN BE DEVELOPED

BY  
J. R. McMILLEN  
AND  
W. B. RUSSELL  
1956

MISSOURI GEOLOGICAL SURVEY  
AND WATER RESOURCES  
ROLLA, MISSOURI

THOMAS R. BEVERIDGE  
STATE GEOLOGIST





SIEVE ANALYSES OF SANDS  
 FOUND AT VARIOUS DEPTHS IN  
 TEST WELL N<sup>o</sup> 119  
 SW<sup>1</sup>/<sub>4</sub>-NW<sup>1</sup>/<sub>4</sub>-SEC.6, T 66N. R25W. MERCER CO., MISSOURI.  
 DALE FULLER, MAR. 1956.  
 MISSOURI GEOLOGICAL SURVEY AND WATER RESOURCES  
 THOMAS R. BEVERIDGE, STATE GEOLOGIST



thousandths of an inch. These plotted points are then connected with a smooth curve. A sand analysis curve shows at a glance how much of the material is smaller or larger than a given particle size. For more complete consideration, the slope and shape of the curves determines the types of well development that should be used.

To attain high yields in sands and gravels requires careful sampling by the well driller. Then, a competent analysis of these samples is the guide to proper well development. Also, good sampling and sieve analyses are necessary to develop low yield (domestic type) wells in sands which are so fine that they require well screens and/or gravel pack treatment.

## SUMMARY

Results of the test drilling program in Mercer County show the following:

- (1) Approximately 22,000 acres of Mercer County are located within the area where irrigation wells possibly can be developed.
- (2) Nearly one-third of Mercer County lies in glacial drift areas where sufficient water supplies for domestic needs are available.

Questions concerning water problems for a specific location should be sent to the Missouri Geological Survey and Water Resources, Buehler Park Box 250, Rolla, Missouri 65401.

Appendix:

Stream flow data, Mercer County

Weldon River near Mercer

Location: - Wire gage, lat.  $40^{\circ}33'$ , long.  $93^{\circ}36'$ , in SW 1/4 sec. 3, T. 66N., R. 24W., at county highway bridge, 4 1/4 miles northwest of Mercer and 5 miles upstream from Little River.

Drainage Area: - 246 square miles.

Records Available: - September, 1939 to September, 1949.

Average Discharge: - 10 years, 166 second feet.\*

Extremes: - 1939-49: Maximum discharge 28,000 second-feet.

June 5, 1947 (gage height, 25.71 feet); from rating curve extended above 14,000 second-feet; no flow on many days in 1940, 1941, and 1944.

Remarks: - Records fair to poor.

Cooperation: - Station maintained by U. S. Geological Survey in cooperation with Corps of Engineers.

Weldon River at Mill Grove

Location: - Wire-weight gage, lat.  $40^{\circ}18'$ , long.  $93^{\circ}36'$ , in SE 1/4 SE 1/4 sec. 28, T. 64N., R. 24W., at county highway bridge in Mill Grove and 8 1/4 miles upstream from West Muddy Creek. Datum of gage is 785.77 feet (revised) above mean sea level, datum of 1929.

Drainage Area: - 494 square miles.

Records Available: - April, 1929 to September, 1949.

Average Discharge: - 20 years, 238 second-feet.

Extremes: - 1929-49: Maximum discharge, 27,600 second-feet.

June 5, 1947 (gage height, 22.79 feet); minimum, 0.2 second-foot.

August 29, 1936; December 11-13, 1937; minimum gage height observed, 0.70 foot October 4, 1948.

Maximum stage known, about 23.9 feet in July, 1909.

Remarks: - Records good to fair except those for periods of ice effect. which are poor.

\* One second-foot equals 448.83 gallons per minute

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Above data from: Bolon, Harry C., Surface Waters of Missouri: Missouri Geological Survey and Water Resources, 2d ser., vol. 34, p. 342 and 351, 1952.